

that we can form some working idea therefrom of general meteorological processes. But let us consider whether we have even attempted for surface meteorology what the patience of astronomers from Copernicus to Kepler did for astronomy.

Do we yet fully comprehend the kinematics of the travelling depression; and if not, are we in a satisfactory position for dealing with its dynamics? I have lately examined minutely the kinematics of a travelling storm, and the results have certainly surprised me and have made it clear that the travelling depressions are not all of one kinematical type. We are at present hampered by the want of really satisfactory self-recording instruments. I have sometimes thought of appealing to my friends the professors of physics who have laboratories where the reading of the barometer to the thousandth of an inch belongs to the work of the "elementary class," and of asking them to arrange for an occasional orgy of simultaneous readings of the barometer all over the country with corresponding weather observations for twenty-four consecutive hours, so that we might really know the relation between pressure, rainfall, and temperature of the travelling depressions; but I fear the area covered would even then hardly be large enough, and we must improve our self-recording instruments.

Then, again, have we arrived at the extremity of our knowledge of the surface circulation of the atmosphere? We know a great deal about the average monthly distribution, but we know little about the instantaneous distribution. It may be that by taking averages we are hiding the very points which we want to disclose.

Let me remind you again that the thickness of the atmosphere in proportion to the earth's surface is not unsatisfactorily represented by a sheet of paper. Now it is obvious that currents of air in such a thin layer must react upon each other horizontally, and therefore we can not *a priori* regard one part of the area of the earth's surface as meteorologically independent of any other part. We have daily synoptic charts for various small parts of the globe, and the Weather Bureau extended these over the Northern Hemisphere for the years 1875 to 1879¹; but who can say that the meteorology of the Northern Hemisphere is independent of that of the Southern? To settle that primary question we want a synchronous chart for the globe. As long as we are unable to watch the changes in the globe we are to a certain extent groping in the dark. A great part of the world is already mapped every day, and the time has now arrived when it is worth while to consider what contributions we can make towards identifying the distribution of pressure over the globe. We may idealize a little by disregarding the local peculiarities without sacrificing the general application. I have put in the exhibition a series of maps showing what approximation can be made to an isochronous chart of the globe without special effort. We are gradually extending the possibility of acquiring a knowledge of the facts in that as in other directions. With a little additional enterprise a serviceable map could be compiled; and when that has been reached, and when we have added to that what the clouds can tell us, and when the work of the aeronautical committee has so far progressed that we can connect

the motion of the upper atmosphere with the conditions at the surface, when we know the real kinematics of the vertical and horizontal motion of the various parts of a travelling storm, we shall, if the universities will help us, be able to give some rational explanation of these periodic relations which our solar physics friends are identifying for us, and to classify our phenomena in a way that the inheritors of Kepler's achievements associated with us in this section may be not unwilling to recognise as scientific.

CLIMATOLOGY OF COSTA RICA.

Communicated by Mr. H. PITTIER, Director, Physical Geographic Institute.

[For tables see the last page of this REVIEW preceding the charts.]

Notes on the weather.—On the Pacific slope the rains were very inconstant, being superior to the normal in some instances and inferior in others. In San José the pressure was markedly above the normal, while temperature was slightly low, with the exceptional minimum of 55.0° on the 25th (the lowest temperature observed heretofore in this month was 55.9°); the relative humidity was also less than the mean. The rainfall, 9.83 inches, occurred almost entirely during the afternoon hours, and was distributed pretty evenly through the month. Sunshine, 187.55 against a normal of 150.42. On the Atlantic slope the rainfall was markedly deficient on the coastal plains, and generally abundant in the valleys and mountains of the interior.

Notes on earthquakes.—September 19th, 5^h 33^m a. m., pretty strong shock NE-SW., intensity III, duration 4 seconds. September 24th, 2^h 53^m, a. m., slight shock NW-SE, intensity II, duration 8 seconds.

THE HURRICANE SEASON.

By ENRIQUE DEL MONTE, Chief of Central Station, Havana, Cuba.

[Translation of a circular letter from the Central Meteorological Station of the Republic of Cuba, dated July 23, 1903.]

It is well known to all that the hurricane or cyclone season of the Antilles embraces a period variable from one year to another, and that the period of duration also varies with regard to its beginning and its ending, although the date of the latter is subject to more regularity than that of the former.

In fact in some years the cyclonic activity manifests itself in June (and even in May, as it happened in 1889), and continues until the end of October; in other years it begins in July and even in August, but terminates in October. This does not mean that every year there will be hurricanes which pass more or less near to us. Some years are recorded in which there has not been any real cyclonic activity, although this is rarely the case; thus during the past year there were no storms that properly deserved the name of hurricanes.

Up to this date the cyclonic activity has not commenced this year, nor does the upper current of the atmosphere appear to indicate that its beginning is near, although conditions may afterwards vary with relative rapidity and may almost unexpectedly inaugurate the hurricane season.

But whatever may be the date at which cyclonic activity begins, tropical hurricanes in their progress are subject to the two following empiric laws:

1. The place of formation of a hurricane is variable, being intimately connected with the time of the year in which storms originate.

2. The hurricane once formed advances in a route or trajectory that varies both with the different periods of the cyclonic activity and with geographical latitudes.

The practical generalization of the two laws we have just mentioned is due to the sagacity and perseverance of one of the highest authorities of modern times in matters relating to hurricanes of the Antilles (we allude to the deceased Father

¹ The Bulletin of International Simultaneous Meteorological Observations was published daily, with a monthly summary, from January, 1875, to December, 1883. The monthly summary alone was continued to December, 1889; it was continued in the MONTHLY WEATHER REVIEW to December, 1895, with the Atlantic Ocean storm tracks. The latter have been kept up by the United States Hydrographic Office and published on the monthly Pilot Charts to the present date. The daily weather maps for the Northern Hemisphere were published with the Bulletin from January, 1877, to November, 1883, but have been preserved in manuscript from January, 1875, to December, 1896, by the Weather Bureau, and since that date by the United States Hydrographic Office. The monthly charts of isobars, isotherms, and wind and storm tracks were published by the Weather Bureau up to December, 1889. The ten-year summary for the years 1878-1887, inclusive, was published as Bulletin A by the Weather Bureau in 1891.—[Ed.]

Viñes). It is clear that there should be such laws, and in fact they are known to all who devote themselves to this study. But it is the duty of the official scientific center, of which we are now in charge, to keep all advised, and in particular seamen who navigate the hurricane region as to the practical utility of the two laws of cyclonic formation and translation which we have just enunciated.

In this matter we believe that nothing can be lost, but, on the contrary, much can be gained by repeating at this time what has long been known to many, but also perhaps unknown to some.

With respect to the first law we derive the following practical conclusions:

1. The hurricanes in August are formed generally to the eastward, very near the Cape Verde Islands. At first they move westward and a little northward, and in the neighborhood of the Windward Islands, pursue a west-northwest direction. The recurve is generally effected by these hurricanes within a zone between the meridians of New Orleans and Puerto Plata, and between 29° to 33° of north latitude.

2. The hurricanes of September originate between Barbados and St. Thomas. The recurve is generally effected between the meridians of Cape Masi (74° W.) and the State of Texas, and between the 27° and 29° of north latitude.

3. The hurricanes of the first decade of October sometimes form in the Windward Islands, or in the eastern part of the Caribbean Sea. These recurve between 23° and 26° of north latitude, in a zone limited by the meridians of Matanzas (82° W.) and Cape Catoche (88° W.). They come very close to Cuba and pass through the western provinces, or the Yucatan Channel.

Consequently the hurricanes described in the three preceding paragraphs always come to Cuba from a great distance and give us plenty of time to take the precautions necessary to diminish their ravages. It is the duty of the observers in the extreme Windward Islands to discover them and announce their formation to us. The Weather Bureau of the United States is in an excellent position to perform this service, inasmuch as during the hurricane season it keeps up, at a heavy expense, five regular stations which communicate by cable twice a day to Washington the state of the weather in the central region of storm formation.

Should any cyclones occur this year during August, September, and the early part of October, the five Weather Bureau observers just referred to will first report them, as they form what may be called pickets or outposts. During these months they will have hard work. As for ourselves we have only to be attentive and wait for the first information from them, as the Republic of Cuba does not yet possess meteorological stations outside of the island. On the other hand, however, from the date of first advice until the end of the hurricane season, the task of discovering cyclones falls altogether upon the observers who are in our zone, as the storms always originate in the vicinity of the Island of Cuba.

4. The hurricanes of the second decade of October commonly originate to the southeast of Havana, some, however, form in the neighborhood of Central America. The recurve is generally made between 20° and 23° north latitude, and in the second branch of their paths they cross the western provinces between Matanzas and Pinar del Rio.

5. The cyclones of the third decade of October originate very near to Central America. They recurve very far to the south, and in the second branch cross the western part of the island of Cuba with great and increasing velocity. These are the hurricanes that demand most attention and care, since although discovered a long time in advance yet we may within a few hours find ourselves in the very center of the storm.

Passing now to the practical generalization of the second of the laws cited at the beginning of this article, or that relative to the routes or normal trajectories of hurricanes, according to the different divisions of the period of cyclonic activity, we deem it better and more profitable to reproduce exactly the paragraphs devoted to this matter by Father Viñes in his last and celebrated work on tropical hurricanes.¹

The law that I have just expounded (that of general routes or trajectories) indicates to seamen the most dangerous zones during the hurricane months and which zones they should endeavor to avoid as much as possible; or if they must pass through them, should try to ascertain, if possible, whether the course is clear of danger or not. If they must navigate the zones described, they should be on the watch for the first indications of a cyclone, in order to take the necessary precautions in time. Leaving the application of this law to the prudence of the mariner, as circumstances may dictate and their courses permit, I will mention several practical cases that may arise.

Sailing vessels making a voyage between South American ports and Havana in the month of August may do so through the Caribbean Sea without danger. In July and September it is also advantageous to sail through the Caribbean Sea, provided they sail in low latitudes; near the Yucatan Channel they must proceed with great care. In the month of October it is very dangerous to make the voyage via the Caribbean Sea, but it may be made to the northward of Porto Rico without probable danger until quite close to Havana.

The voyage from Havana to Spain by steamer through the new channel is not dangerous if made with care. Upon leaving Havana, through telegrams received from the Windward Islands and observations made in the island of Cuba, the captain of the ship may, in the greater number of cases, be kept informed of the best date and be assured of safety while passing through the channel. Once to the north of it, he should work to the east, sailing south of the Bermudas, and within forty-eight hours after leaving Havana he will have crossed the zone frequented by the August hurricanes and will have entered the anticyclone of the Atlantic, with the advantage that if any cyclone should reach him during his voyage, it will pass at some distance to the north, and he can utilize its winds for his voyage. The navigator may object that he will thereby lose time, but he would probably lose much more if he should meet a cyclone. There was a distinguished captain in the Lopez Line who always took this course, and he never regretted it.

Steamers that leave Havana in August for New York, and vice versa, should utilize the Gulf Stream by keeping toward the eastward or right of the current on the northward journey; and on leaving New York for Havana they should not try to avoid the current by nearing the coast of the Gulf of Charleston, but sail easterly, or on the right of the stream. This offers two advantages, the first is that they avoid the part of the route most frequented by August hurricanes, and the second is that they escape being caught between the path of the cyclone and the coast, as happened with the horrible shipwreck of the *City of Vera Cruz*. By sailing away from the stream in an easterly direction navigators have an open sea, and when a hurricane threatens them, if they see that it is going to recurve to the Gulf of Charleston, they may tack under advantageous conditions. If they see that it is recurring farther to the eastward, they can continue their voyage by following the channel, thus utilizing the winds of the cyclone.

The September hurricanes in a voyage to Spain are even easier to avoid, because they either recurve on the coast of Texas, or else recurve in Florida or its vicinity, and these can be avoided, provided that upon leaving Havana the captain knows that he has time to enter the channel without danger.

The voyage from Havana to Porto Rico and vice versa, in September, and especially at the beginning of that month, is very dangerous, because it is exactly in the path of the hurricanes. This voyage should be avoided as much as possible.

The captains of vessels leaving Santiago de Cuba for the United States in August and September, and having to enter the hurricane zone, should not sail without first ascertaining whether there are any indications of a cyclone to windward. Several ships have been saved from great damage by taking this precaution.

Finally, if the master of a sailing vessel navigating in the Gulf of Mexico in the month of October, finds himself in the eastern part of the Gulf, and detects indications of the proximity of a cyclone, he should at once head to the southwest, and if in the vicinity of the Yucatan Channel, he should sail toward the Gulf of Campeche, because these cyclones generally recurve before they pass the meridian of Cape Catoche or that of New Orleans.

¹ See B. Viñes Investigation of the Cyclonic Circulation and the Translatory Movement of West Indian Hurricanes. Weather Bureau, Washington, 1898.